Condition and length-weight relationship of *Dentex gibbosus* from Adriatic Sea, Croatia

by

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ABSTRACT. - The aim of this study was to determine the condition and length-weight relationship of the pink dentex *Dentex gibbosus* (Rafinesque, 1810). The research was conducted in the Adriatic Sea from May 1997 to November 2000. A total of 1186 specimens (7.00-105.70 cm TL) were collected with traditional fishing gears. Positive allometric growth was recorded for the total sampled population (b = 3.0943) and for males (b = 3.1759), while our findings indicate isometric growth for females (b = 3.0272) and immature (b = 3.00) specimens. Fullton's condition factor (K) was calculated, indicating the highest values in mature specimens of both sexes. K values were significantly different between sexes. These results could be useful for fishery managers, because this species is economically valuable.

RÉSUMÉ. - Facteur de condition et relation longueur-poids de *Dentex gibbosus* en mer Adriatique, Croatie.

Le facteur de condition et la relation de longueur-poids du gros denté rose *Dentex gibbosus* (Rafinesque, 1810) ont été déterminés en mer Adriatique de mai 1997 à novembre 2000. Un total de 1186 exemplaires (longueur totale comprise entre de 7,0 et 105,7 cm) a été capturé pour cette étude avec du matériel traditionnel de pêche. Une croissance allométrique positive a été enregistrée pour la population totale (b = 3,0943) et pour les mâles (b = 3,1759), mais nos conclusions indiquent une croissance isométrique pour les femelles (b = 3,0272) ainsi que pour les immatures (b = 3,00). Le facteur de condition de Fullton (K) a été calculé et les plus hautes valeurs ont été observées chez les adultes des deux sexes. Les valeurs du facteur K étaient significativement différentes entre les sexes. Ces résultats pourraient s'avérer utiles pour les gestionnaires de pêcherie car cette espèce présente une valeur économique.

Key words. - Sparidae - *Dentex gibbosus* - MED - Adriatic Sea - Condition - Length-weight relationship.

The condition of fish and related length-weight relationship are widely used parameters, which enhance the understanding of general condition of fish, its growth, survival, maturity and reproduction (Le Cren, 1951). These parameters are also broadly used in the estimation of weight from length, conversion of growth in length equations to growth in weight equations in stock assessment models, estimation of biomass from length, indication of sex and between-region differences and for comparison of the individuals of the same species (Wootton, 1990; Tsoumani *et al*., 2006).

Dentex gibbosus is a demersal marine fish distributed throughout the Mediterranean and the East Atlantic from Portugal to Angola. The juvenile fish live close to the shore, often inhabiting estuaries (Papaconstantinou and Tortonese, 1980). Adults inhabit rocky and sandy bottoms of deeper waters up to the limit of the continental shelf (Fernandez-Palacios *et al*., 1994). As carnivorous species, its diet is mainly composed of teleosts, crustaceans and cephalopods (Bauchot and Hureau, 1981). It is considered as a rapid-growing sparid that grows to a length of 1.2 m and a weight of 25 kg (Jardas, 1996). The pink dentex is a rudimentary hermaphrodite and sexual dimorphism is clearly visible in males longer than 55 cm by the formation of the conspicuous lump on their forehead. Juvenile specimens exhibit the longer spines in the dorsal fin (3rd, 4th and 5th spine). This characteristic is lost in adults (Grubišić *et al*., 2007). The ontogenetic morphological change of dentex is an interesting issue to study with respect to condition factor and L-W relationship.

The comparative biology of fish from the genus *Dentex* (Sparidae) of the northwest African coast was first described by Nguyen-Xuan and Wojciechowski (1972). A comprehensive research of the pink dentex population dynamics off the Canary Islands and its biology is provided by Pajuelo and Lorenzo (1995). The preliminary comparative studies have shown that pink dentex display high survival rates and excellent growth potential. The growth rate was much higher than in other studied sparid species (Katavić *et al*., 2000). The length-weight relationship were previously estimated for *D. gibbosus* from 25.8 to 47.8 cm long caught in Croatian estuaries (Dulčić and Glamuzina, 2006), but there was no data for longer/older individuals caught in the open sea. The aim of this study was to determine the condition and length-weight relationship of the species in the eastern Adriatic and using the relevant parameters to test differences between sexes.

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MATERIALS AND METHODS

Between May 1997 and November 2000, 1186 specimens of pink dentex were collected by bottom trawl, hook-and-lines and bottom long lines in the Eastern Adriatic Sea (Fig. 1). Fish were measured to the nearest 0.1 cm in total length (TL), and grouped into 0.5 cm size classes. The individual weights of the fish (W) were determinate with an accuracy of ± 0.01 g. The length-weight relation was studied using the formula given by Pauly (1983). Fullton's condition factor (K) was calculated according to descriptions given by Ricker (1975). All results obtained in these analyses of pink dentex are carried out for female, male and immature specimens, as well as for all specimens together. Sex ratio (M:F) was analysed using the chi-squared test (χ^2).

The sample descriptive statistics, such as range, mean value, standard deviation, 95% confident interval and coefficient of determination were calculated to describe numerical results. Due to fact that many statistical tests depend on the assumption that the measurements in the sample were obtained from a population that follows Gaussian distribution, Kolmogorov-Smirnov normality test at 0.05 α-level was applied. Eventually, with aim to analyse differences between sexes and relative growth of the fish's body (i.e. changes in length and weight), t-test was used (Sokal and Rohlf, 1997). Null-hypothesis assuming that fish grow is isometric (H_0: W = aTL^3) during specimen's life has been tested.

RESULTS AND DISCUSSION

From the total of 1186 specimens of *D. gibbosus* collected during the study period, 30.62% were males, 37.18% were females and 32.20% were immature specimens or hermaphrodites. The overall ratio of males to females was 1:1.21, and a χ^2 test showed no significant difference from a 1:1 ratio ($p > 0.05$).

Length-weight relationships for males, females, immature specimens and total population sampled were determined as $W = 0.0072\ TL^{3.1759}$, $W = 0.0136\ TL^{3.0272}$, $W = 0.0137\ TL^{3.0000}$ and $W = 0.0102\ TL^{3.0943}$ respectively.

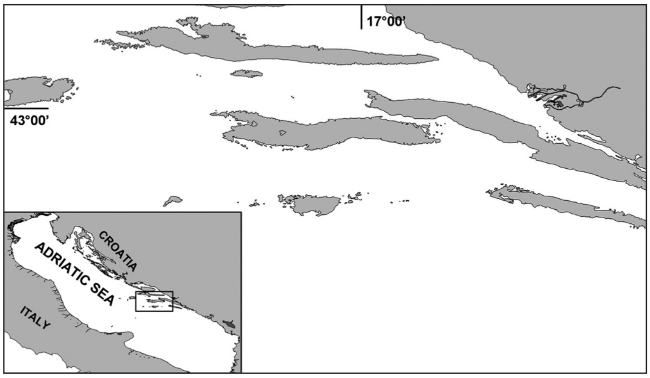

Figure 1. - Map of study area. *[Carte de la région d'étude.]*

Sample size, total length range, estimated parameters, 95% confidence intervals of b, coefficient of determination (r^2) and growth types are given in table I. Kolmogorov-Smirnov (K-S) test indicated non-significant differences from normal distribution ($p > 0.05$) of data, while t-test showed that there was significant difference in L-W relationship between sexes ($p < 0.05$). The growth of females and immature specimens did not differ significantly ($p > 0.05$) from isometric growth ($b = 3$), while the results for males and total population sampled showed significant deviation ($p < 0.05$) from isometric growth, indicating positive allometric growth ($b > 3$).

Pajuelo and Lorenzo (1995) calculated the length-weight relationship of *D. gibbosus* from the Canary Islands, with a resultant lower *b* value ($b = 3.0812$) than for the Adriatic Sea population. These differences are probably associated with the different size structure of the *D. gibbosus* population from Canary Islands where 79% of population were smaller then 50 cm while from Adriatic Sea only 39.8%. Their parameters of L-W relationship indicate the positive allometric growth for both sexes (males: $a = 0.00435$; $b = 3.2960$; females: $a = 0.00823$, $b = 3.1304$).

The result of isometric growth of immature population is in accordance with Nguyen-Xuan and Wojciechowski (1972), who found $b = 3.0$ for up the five years old pink dentex population from the northwest African coast, but witch differ from those of Dulčić and Glamuzina (2006) who obtained the value of b = 3.13 respectively, in pink dentex from Croatian estuarine systems.

Table I. - Length-weight relationship parameters for male, female, immature and total sampled population of *Dentex gibbosus* from Adriatic Sea. n, sample size; TL, total length; SD, standard deviation; CI, confidence interval; a, proportionality constant; b. slope; r2, coefficient of determination; I, isometric growth; A+, positive allometric growth. *[Paramètres de la relation longueur-poids pour les mâles, les femelles, les immatures et l'ensemble de la population échantillonnée de* D. gibbosus *en mer Adriatique.]*

D. gibbosus	n	Length characteristics		Parameters of the relationship				Growth type
		TL range (cm)	Mean TL (± SD)	*a*	*b*	(95% CI of *b*)	r^2	
Male	363	38.7 - 101.2	63.2 ± 15.5	0.0072	3.1759	3.1249 - 3.2268	0.987	A+
Female	441	39.8 - 105.7	64.6 ± 15.5	0.0139	3.0272	2.9836 - 3.0708	0.984	I
Immature	382	7.0 - 55.2	24.3 ± 11.1	0.0137	3.0000	2.9518 - 3.0482	0.996	I
Total sample	1186	7.0 - 105.7	51.2 ± 23.4	0.0102	3.0943	3.0675 - 3.1213	0.997	A+

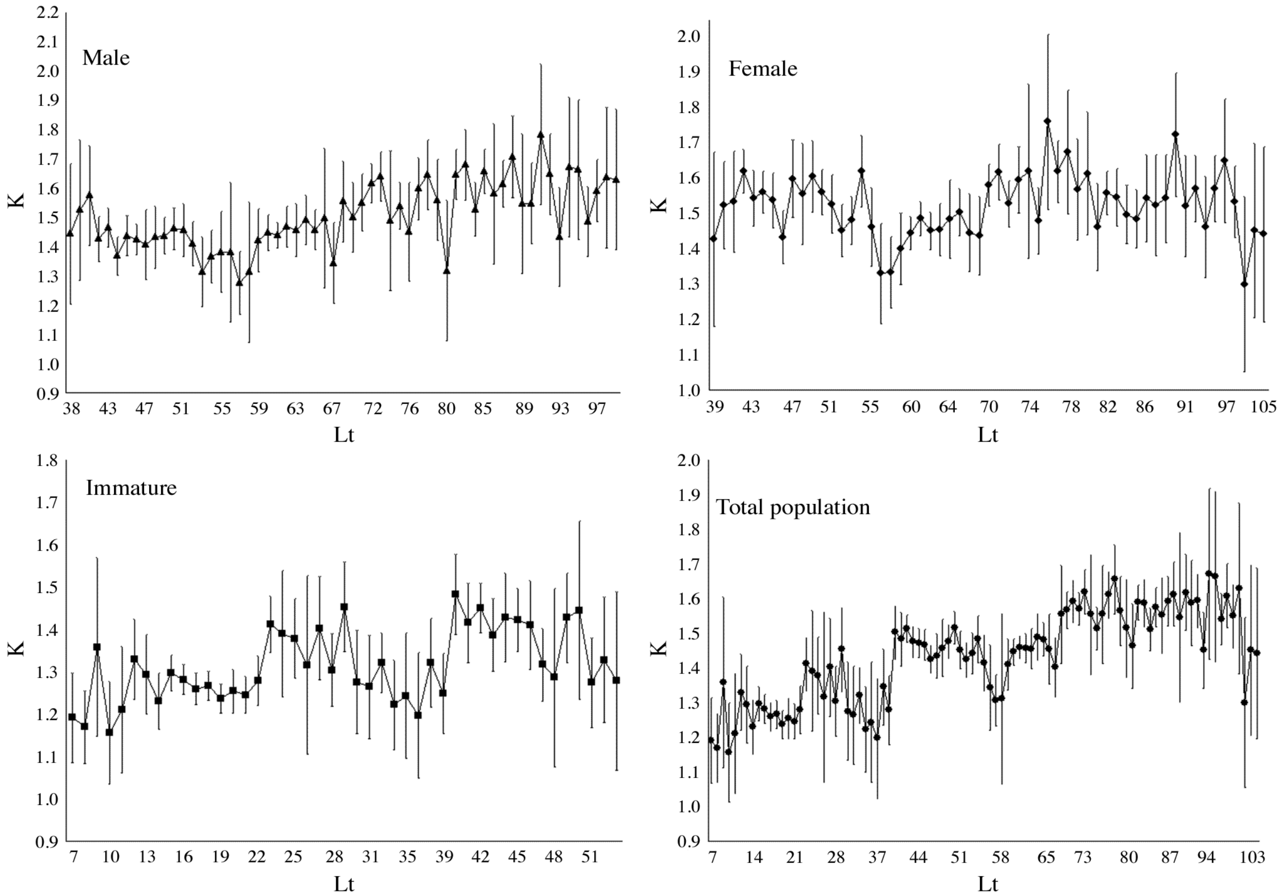

Figure 2. - Variation of Fulton (K) condition factor for males, females, immatures and total population of pink dentex *Dentex gibbosus* in relation to the total length (TL); vertical bars = 95% confidence intervals. *[Variation du facteur de condition de Fulton (K) par rapport à la longueur totale (LT) pour les mâles, les femelles, les immatures et la population totale échantillonnée de gros dentex rose* D. gibbosus *; barres verticales = intervalle de confiance à 95%.]*

Fulton's condition factor (K) showed various oscillations (Fig. 2). The first oscillations of the condition factors of pink dentex have been determined during the period of adolescence and the first sexual maturity, within size classes from 9 to 35 cm. The highest values were found in mature specimens, while slightly lower K values were calculated for the longest and oldest specimens. K values ranged from 1.307-1.661 in males and from 1.335-1.653 in females. There were no significant differences between sexes in K values ($p > 0.05$), but regular oscillations of K values during growth of pink dentex were observed.

The lowest K values were found for the smallest specimens (size classes from 9 cm to 35 cm) of pink dentex were caught with a bottom trawl during winter season when sea temperature ranged from 11.7-12.2°C. It is likely that low temperatures have affect on the fish metabolism and the feeding intensity. Francis (1997) also recorded, for the two old populations of *Pagrus auratus* from the Australian coast, the lowest K value at the sea temperature of 10 to 13°C. According to Rijavać (1975), temperature has been related to inter-annual fluctuation in condition of *Pagellus erythrinus*, where the lowest K value was found in January-February, whereas the highest value of K was achieved in September.

The oscillation of K values, at the lengths between 35 and 41 cm is probably related with species sex formation and the first sexual maturity. According to Grubišić *et al.* (2007), the pink dentex population from the Adriatic Sea that displayed rudimentary hermaphroditism (late gonochorism) composed 50% of the population sexually matured at 41.5 cm. Katavić (1984) described the positive correlation between values of gonadosomatic index and Fulton's condition factor for the gilthead sea bream, *Sparus aurata*.

Across the length range of 39 to 57 cm, females have slightly higher K values then males that might be related to higher female gonadosomatic index (Grubišić *et al.*, 2007). Lorenzo *et al.* (2002) also noted that the values of the gonadosomatic index for male were commonly lower than those for female on reviewing the reproductive biology of the sparids.

Reaching the length of 57 to 67 cm, when sexual dimorphism is clearly visible in males by the formation of a conspicuous lump at the front part of the head, K values for both sexes becomes equal, probably as a consequence of formation of a protuberance on the males' forehead which affects the L-W relationship and K positively by increasing their weights. Our findings confirm this hypothesis that males' lower value of gonadosomatic index than in females is compensated by weight of the protuberance formation, resulting in similar K values of mature female and male specimens.

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